Lab 4. Time-Varying Fields

Name: _____

Section: _____

Due at the beginning of Lab.

Task 7. The Blown Transformer

You've got a new and better position in the R&D department of a company producing digital electronic devices. One day, while you are working on a project with approaching deadline, the 5-V power supply in the lab burns out. You check the unit and find out that the rectifier and the stabilizer are ok, but the transformer has burned out. You order a new power supply but it will arrive the next day and you cannot afford to loose a whole day. You know that designing and building the transformer shouldn't take more than an hour. So, you decide to do it in order to save the day. To get 5 volts from the supply, the output of the transformer must be at a somewhat higher voltage since the rectifier and the stabilizer will lower it further.

So, you need to construct a transformer that will convert the 120 V_{rms} from the outlet into 8 V_{rms}. The transformer must provide 40 W of power.

In the lab, there is a ferromagnetic material in the form of a long cylindrical rod. You decide to use this material to make the transformer in the form of two coaxial coils (two solenoids sharing the same core).

First, you need to figure out wires of what diameters are to be used in the primary and the secondary coils so that get the necessary wires from the stock room. You are sure that the current density in the wires should not exceed 2.5 A/mm^2. You decide to assume that the transformer is ideal and to counteract this assumption by incorporating a safety factor of 1.5 in your calculations to make sure the maximum permissible current density won't be exceeded under any circumstances.

What is your choice about the wires' diameters and why? Back up your answer by showing all the steps of your analysis and computation.

Task 8. The Navy Project

You have successfully obtained a Bachelor's degree in EE and currently you are enrolled in the graduate program of the EE Department. You want to taste a real research, so you've chosen the thesis option for your Master's degree. You work under the supervision of a faculty member who has just secured a contract with the Navy. It is about RF communications with submarines. The Navy has provided the following data: The shore base station can emit within the frequency range 1KHz to 1MHz with a signal strength, such that just below the water surface it is 10 mV/m. The submarine receiver can tolerate attenuation of 60 dB with respect to the waves amplitude just below the water surface.

Your boss has asked you to obtain a log-log curve showing the frequency dependence of the maximum depth, at which a submarine can still receive messages from the shore base station.

You quickly review the decibel scale for amplitude and power ratios and realize that the sensitivity of the receiver is …

What is the sensitivity (the minimum signal strength that would be detected reliably) of the submarine receiver?